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The development of the endosperm in Vaccinium corymbosum

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(WITH FOUR TEXT FIGURES)

The occurrence of a "chambered" embryo sac, formed by the development of a transverse wall following the first division of the primary endosperm nucleus, has been reported in four genera of the Ericaceae. In recent studies of the high bush blueberry, *Vaccinium corymbosum* L., the writer has noted a variation from this of sufficient interest to warrant brief publication.

In 1849 Hofmeister (2) published an account of the development of *Monotropa Hypopitys*. According to his descriptions and figures (*pl. 12, f. 11*) the embryo sac in this species is first cut in two by a cross wall near the middle; afterwards cross walls are formed in each half and the micropylar end is cut off by a wall, thus resulting in an embryo sac of five superimposed cells. Nine years after the publication cited above Hofmeister described the development of *Vaccinium Myrtillus* and *Pyrola rotundifolia* (3), in both of which he found that the development of the endosperm took place as in the *Monotropa* without free nuclear division.

Koch (4), in his studies of *Monotropa Hypopitys*, largely confirms the work of Hofmeister. His figure (*pl. 10, f. 12*) closely resembles that of Hofmeister except that he finds no cross wall near the micropylar end and thus figures a four-chambered, instead of a five-chambered, embryo sac.

In the trailing arbutus, *Epigaea repens*, the writer (5) found a condition much like that reported in other genera. His figure of the *Epigaea* (*f. 3*) very closely resembles Koch's figure of the *Monotropa*, a fact which the writer apparently overlooked in his earlier paper (5, p. 540). The writer also reported the occurrence in the *Epigaea* of haustoria extending out into the tissues of the integument from the ends of the developing endosperm.

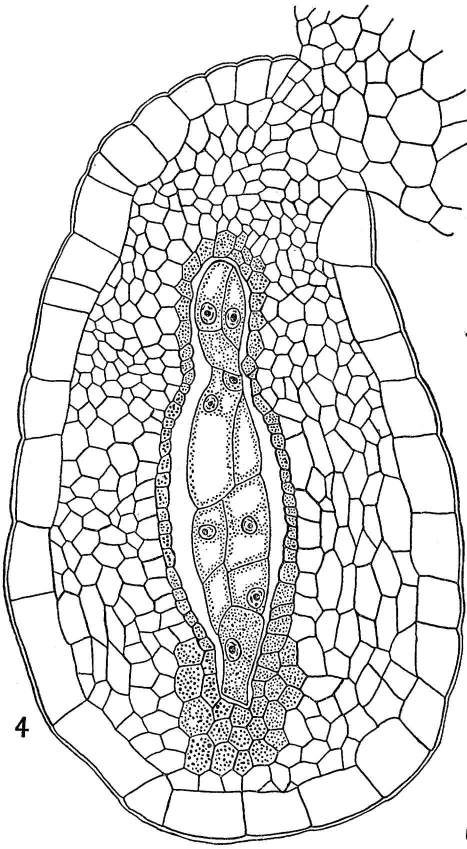
The slides of *Vaccinium corymbosum*, on which the present notes are based, were all made from material collected at East

Wareham, Massachusetts, during June, 1916. The material was fixed in a solution of equal parts glacial acetic acid and absolute alcohol, imbedded in paraffin, cut and stained in the usual way. From a study of this material it is apparent that the development of the endosperm of this species may begin in two quite different ways, either by the formation of a cross wall following the first division of the primary endosperm nucleus as has been reported in the other genera of the Ericaceae, or by a period of free nuclear division as has been described in a very large number of species.

FIG. 1 shows a typical two-chambered embryo sac much like those described in *Monotropa* and *Epigaea*. The material examined also showed the four-chambered stage which characteristically follows this. FIG. 2, on the other hand, illustrates an embryo sac which has developed by free nuclear division. The stage represented by FIG. 3 may obviously have resulted from free nuclear division followed by the beginning of wall formation near the center of the embryo sac, or there may have been some free nuclear division after the formation of the cross walls.

FIG. 4 shows a somewhat more advanced stage, in which the irregular arrangement of the cell walls suggests that there was a period of free nuclear division. In this figure the layer of small cells with dense protoplasm (shaded) represents the "tapetum" mentioned in *Epigaea* (5, *f. 4*). The developing haustoria may also be noted. The antipodal haustorium consists of only one cell, while the micropylar haustorium contains three. In the mature seed of *Vaccinium corymbosum* the haustoria are larger than in the seed of *Epigaea repens;* their development also begins relatively early. In *Epigaea* when the embryo is in the eight-celled stage and the endosperm well differentiated both haustoria are still small and consist of but a single cell, whereas in *Vaccinium* the haustoria have attained a considerable size before any divisions of the fertilized egg are apparent.

Hofmeister found that *Vaccinium* (3, p. 141) differed from the other genera described by him in that after the formation of the first wall across the embryo sac, endosperm developed only in the antipodal chamber, while in *Monotropa* and *Pyrola* endosperm developed in both chambers (see also Coulter and Chamberlain, 1, p. 177). The condition found by the writer in *V. corymbosum*



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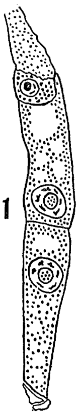

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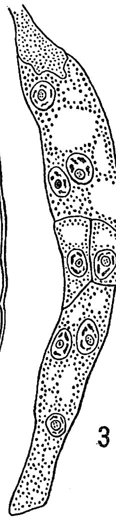

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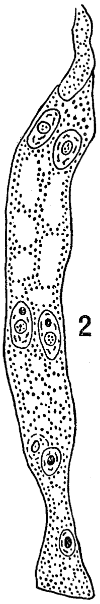

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FIG. 1. Longitudinal section of embryo sac of *Vaccinium corymbosum* in two-celled stage; the fertilized egg and the remains of the pollen tube may be seen at the upper end and the remains of the antipodal cells at the lower end. ×290.

FIG. 2. Embryo sac of *V. corymbosum* which shows only free nuclear division. × 290.

FIG. 3. Embryo sac from the same ovary as that in FIG. 2, showing two cross walls and evidence of free nuclear division. × 290.

FIG. 4. Longitudinal section of ovule of *V. corymbosum* showing few-celled endosperm with haustoria developing at either end. The inner cells of the integument are specialized to form a tapetum, being more densely crowded with protoplasm and generally smaller than the other cells of the integument. The walls of the epidermal cells are already somewhat thickened. × 170.

represents a still further variation and suggests the desirability of a careful study of the development of the endosperm in other genera of this family. The writer has, however, been able to examine only one. Slides of *Kalmia latifolia* made from material collected at Vienna, Virginia, on May 28, 1916, showed embryo sacs before division and in the two-celled and four-celled stages. Material collected August 13, 1916, showed the endosperm with haustoria at either end, the whole condition very closely resembling that described in *Epigaea.*

The significance of the condition described in *Vaccinium corymbosum* lies of course in the fact that here occur in a single species types of development hitherto associated with different genera or even different families. All the figures were drawn from material collected from a single plant and FIGS. 2 and 3 represent ovules in the same ovary. Examination of a large amount of material of the other genera described might result in finding variations as marked as those in the *Vaccinium.*

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